Office of Operating Experience Analysis, EH-33 • U.S. Department of Energy • Washington, D.C. 20585

OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

April 30 - May 6, 1999

Summary 99-18

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EVENTS

1. FLAME OBSERVED DURING FILTER TESTING AT WEST VALLEY

On April 27, 1999, at the West Valley Demonstration Project, plant operators performing an in-place system leak test of a high-efficiency particulate air (HEPA) filter observed a flame emanating from the discharge port of a thermal aerosol generator used for the test. One of the operators immediately closed flow and control valves on the generator, which extinguished the flame. There were no personnel injuries or equipment damage other than scorched piping insulation adjacent to the aerosol generator. The operators performed the test using an aerosol whose characteristics were not recognized by either the aerosol generator manufacturer or the West Valley operators as being incompatible with the design of the aerosol generator when certain conditions exist. The operators also manipulated the generator's valves in a sequence prescribed by an approved procedure, but the sequence contributed to ignition of the aerosol and created the flame. The following day, the operations manager initiated a site-wide hold on the performance of all in-place HEPA filter testing with a thermal aerosol generator. This near miss is significant because the improper operation of thermal aerosol generators can cause serious personnel injury and can damage equipment. (ORPS Report OH-WV-WVNS-CF-1999-0002)

The efficiency of a HEPA filter is determined by introducing a thermally generated challenge aerosol (smoke) upstream of the filter and then measuring the concentration of the aerosol downstream of the filter. The aerosol is thermally generated to achieve a small enough particle size to challenge the filter media and allow measurement of its efficiency. Investigators determined that the operators, following the approved procedure, activated the aerosol generator to the 720 degrees Fahrenheit setpoint required by the procedure and were at the point of aerosol generation when a 2 to 3 ft long flame appeared at the generator's discharge port. Commonly used challenge aerosols for in-place system leak tests are di-octyl phthalate, also known as DOP or DEHP, and di-octyl sebacate, known as DOS or DEHS. However, DOP has been designated as a carcinogen and some DOE facilities have switched from using DOP to a synthetic hydrocarbon, polyalphaolefin (PAO). Investigators determined that on January 1, 1999, the West Valley Site replaced DOP as the challenge aerosol with PAO. West Valley operators have successfully performed HEPA filter testing 13 times since the beginning of 1999 using PAO as the aerosol. Investigators also discovered that the autoignition temperature for DOP is 735 degrees and that the autoignition temperature for PAO is 650 degrees. The aerosol generator used for the test, a NUCON™ F-1000-DG Model F, is designed to maintain a nonadjustable temperature of 720 degrees, and if the control and flow valves are manipulated in a certain sequence a flame can be created from the autoignition of PAO.

On May 3 and 4, 1999, the thermal generator manufacturer tested similar equipment with PAO at its facility in an attempt to recreate the West Valley event. The test technicians determined that under the same flow conditions and with the same valve manipulations as were performed at West Valley, they observed flames at the aerosol discharge port in approximately 75 percent of the tests. The current vendor manual for this aerosol generator recommends a valve manipulation sequence that is different from the West Valley approved procedure. However, the manufacturer revised the valve sequence in the vendor manual several years ago, and at that time, Nucon and West Valley personnel only considered the changes to be editorial in nature. The vendor manual was not revised in response to any event or concern.

The changes being initiated in response to this event and the investigatory tests include the following.

- West Valley personnel will change the aerosol generator operating procedures to reflect the valve manipulation sequence currently recommended by the generator manufacturer, and appropriate cautions will be added to the procedures to alert operators to the correct valve manipulation sequence.

- The manufacturer will modify all aerosol generators of this model type at West Valley to change the heater-block-controller temperature setpoint to 625±25 degrees. West Valley personnel will incorporate warnings and cautions into the operating procedures to have operators verify this temperature range prior to initiating aerosol flow.

- The manufacturer will also modify the aerosol generators to ensure that even if an incorrect valve manipulation sequence is performed, a flame will not be generated.

OEAF engineers searched the ORPS database for other events involving challenge aerosols and filter testing. Some examples follow.

- In October 1996, operators at the Hanford Site were performing a HEPA filter penetration test when they heard a loud pop and observed excessive smoke coming from the aerosol generator. Investigators inspected the internals and setup of the aerosol generator and tested it. They determined that the aerosol generator might have been operated improperly, allowing the aerosol to ignite. (ORPS Report RL--PHMC-GENERAL-1996-0002)

- In April 1996, Brookhaven National Laboratory (BNL) managers reported that beginning in 1994 they substituted PAO for DOP to perform filter efficiency testing. They did so because DOE recognized that PAO is a less hazardous substance than DOP. The substitution of PAO for DOP violated BNL's technical safety requirements (TSR), which specifically stated that DOP be used. This event happened because Brookhaven "…management failed to recognize that a general recommendation by the DOE to use [PAO] for filter efficiency testing did not constitute official approval of a deviation from the literal requirements of the TSRs." Brookhaven managers subsequently requested and received approval to change the laboratory's TSRs to allow using a substitute challenge aerosol. (ORPS Report CH-BH-BNL-CF-1996-0001)

- In April 1993, operators at the Hanford Site were testing a newly installed filter bank with 12 aerosol generators when they heard an unfamiliar sound and noticed that a small fire had developed in several of the plastic hoses leading from the discharges of the generators to the filters. Investigators determined that one of the generators had run out of aerosol liquid and that the operators refilled the generator without first deactivating it. They also determined that this action disrupted the flow of nitrogen through the generator, which allowed ignition of the aerosol. (ORPS Report RL--WHC-WHC200EM-1993-0018)

- In January 1992, Hanford Site managers reported that from mid-1991 and into 1992, PAO was used as the challenge aerosol for HEPA filter testing. Because DOP and DOS were suspected to be carcinogens, the managers had revised their maintenance procedures to allow the use of PAO even though DOE did not approve it for use. The Richland Operations Office subsequently requested and received DOE approval to use a specific brand of PAO for in-place HEPA filter testing. (ORPS Report RL--WHC-WHC200EM-1992-0002)

These events underscore the hazards associated with the use of a thermally generated aerosol for filter testing and the importance of ensuring compliance with facility and DOE requirements. Filter-testing personnel should be trained and qualified in the proper use of aerosol generators and be thoroughly familiar with the generator's operating procedures and characteristics. They should also be more aware of the hazards associated with what some operators may assume to be a routine maintenance activity. Facility managers and supervisors involved in filter testing should ensure that the challenge aerosol they use complies with the facility's technical operating requirements. Filter-testing personnel should consult the manufacturer of any thermal aerosol generator being used before switching from one challenge aerosol to another to ensure that the new aerosol being considered is compatible with the design of the generator. When aerosol generators or aerosols are being changed, the generator manufacturer should also be consulted to provide input to update the generator operating procedures and the training curriculum for filter-testing personnel. Any change in aerosol type or methods of in-place filter testing requires a thorough analysis of policies and procedures to ensure personnel safety and to ensure that proper approvals are obtained.

Presently, there is no DOE standard governing in-place HEPA filter testing. Some current references associated with HEPA filter testing follow.

- Office of Health Draft Hazard Alert OH-93-1, *Di-Octyl Phthalate*, discusses the carcinogenicity of DOP, contains basic information about DOP, and provides recommendations for reducing workplace exposure to this aerosol. This alert can be accessed at http://nattie.eh.doe.gov/docs/hha/.

- ASME Standard N510-1989, *Testing of Nuclear Air Treatment Systems*, provides guidance to develop a test program for in-place leak testing of HEPA filters, including visual inspections and challenge aerosol tests using DOP or DOS.

- ASTM Standard F 1471-93, *Standard Test Method for Air Cleaning Performance of a High-Efficiency Particulate Air-Filter System*, covers the procedure and equipment for measuring the penetration of test particles through HEPA filter systems using a laser aerosol spectrometer.

For information concerning in-place HEPA filter testing, contact Jim Slawski at (301) 903-5464 or e-mail at James.Slawski2@ns.doe.gov. For information concerning NUCON™ thermal aerosol generators, contact Curt Graves at Nucon International, Inc., at (614) 846-5710 or e-mail at curtgraves@nucon-int.com.

KEYWORDS: aerosol, compliance, flame, generator, HEPA filter, occupational safety, smoke

FUNCTIONAL AREAS: Licensing/Compliance, Industrial Safety, Training and Qualification

2. GOOD COMMUNICATION PRACTICE IDENTIFIED AT PADUCAH SITE

This week OEAF engineers identified a good practice involving communication between site facilities. On April 27, 1999, Paducah Gaseous Diffusion Plant managers reported that in early February the driver of a DOE-NCH-35 cylinder hauler discovered cracks in the welds of mounting brackets for hydraulic-line guide blocks while performing a routine inspection. This type of cylinder hauler is in use at the Paducah and Portsmouth gaseous diffusion facilities and at the East Tennessee Technology Park (ETTP). Engineers at Paducah inspected the cracks and notified engineers at Portsmouth and ETTP so they could inspect their cylinder haulers for similar problems. Sharing the information about the guide block weld cracks with the other facilities with similar equipment may have prevented an equipment failure. (ORPS Report ORO--BJC-PGDFENVRES-1999-0002)

The cylinder hauler, which is used to transport 14-ton depleted uranium hexafluoride casks, is manufactured by Allied Wagner (figure 2-1). It is one of three at Paducah and had been in use for between 5 and 7 years. The guide blocks, which are mounted on top of the boom of the cylinder hauler, guide hydraulic lines when the cylinder hauler operator is extending or retracting the boom. Although the guide blocks, their mounting brackets, and the bracket welds do not serve a safety function, the boom is classified as a safety-significant component. By performing dye penetrant checks after the guide block welds were removed, investigators determined that the cracks in the guide block welds had propagated into the base metal of the cylinder hauler boom, which could have caused a structural failure. They believe that fatigue from the sliding motion of the guide blocks caused the cracks and their propagation into the boom. Engineers also found cracks in the guide block welds of the other two cylinder haulers at Paducah and are investigating to see if those cracks have also spread into the booms. No weld cracks have been identified in the cylinder haulers at the Portsmouth or ETTP facilities.

Figure 2-1. DOE-NCH-35 Cylinder Hauler

The engineers at Paducah, Portsmouth, and ETTP communicate regularly to share information about weekly accomplishments, upcoming plans, cylinder moves, inspection results, and identified problems. They also use the DOE Lessons Learned Program and the Occurrence Reporting and Processing System to identify generic concerns. NFS has reported other events where lessons learned from one facility were applied at another facility. Some examples follow.

- Weekly Summary 98-28 reported that Savannah River Site H-Tank Farm operators notified F-Tank Farm operators during a daily conference call that they had identified a confined space entry violation that could also be occurring at F-Tank Farm. F-Tank Farm managers ordered a review of confined space permits and discovered that their operators had also violated confined space entry procedures. The facility manager requested that the training group develop a briefing on confined space procedure requirements and work with operator personnel to develop lessons learned. (ORPS Report SR--WSRC-FTANK-1998-0015)

- Weekly Summary 96-30 reported that facility managers at the Oak Ridge Y-12 Plant reported potential structural degradation of the concrete floor in two buildings. Initially, personnel at Oak Ridge were alerted to the potential problem by a June 1995 Defense Nuclear Facilities Safety Board report of a similar condition at the Rocky Flats Environmental Technology Site. Managers at Oak Ridge used techniques learned at Rocky Flats to identify and correct the problem. (ORPS Report ORO--LMES-Y12NUCLEAR-1996-0017)

- Weekly Summary 96-13 reported that Analytical Development Section personnel at the Savannah River Technology Center had evaluated a yellow alert from the Lessons Learned List Server on a centrifuge failure. Although they did not have centrifuges of the type described in the alert, they evaluated the information for generic implications. The corrective actions they implemented prevented injury when an operating centrifuge at their facility became unbalanced. (DOE Lessons Learned List Server Item Number 1996-SR-WSRC-LL-0002)

These events are significant because they illustrate the value of sharing lessons learned and applying them at other sites as well as recognizing and responding to both good practices and potential problems. Facility managers and supervisors are encouraged to openly communicate with their counterparts at other facilities with similar missions, functional areas, or equipment and should refer to the following references for guidance on lessons learned.

- DOE-STD-7501-95, *Development of DOE Lessons Learned Programs,* defines the framework for development of a lessons learned program. The purpose of developing lessons learned is to share and use information to (1) promote the recurrence of desirable activities or (2) preclude the recurrence of undesirable activities.

- DOE-HDBK-7502-95, *Implementing the DOE Lessons Learned Programs, Volumes I and II,* discusses how to implement an effective lessons learned program.

The DOE Lessons Learned Program can be accessed at http://www.tis.eh.doe.gov/others/ll/ll.html. The site offers a search capability with links to DOE lessons learned programs at sites and headquarters and to lessons learned programs in the private sector and at other public agencies.

KEYWORDS: boom, communication, good practices, industrial safety, lessons learned, weld

FUNCTIONAL AREAS: Lessons Learned

3. REFLECTED LASER LIGHT BURNS CEILING TILE

On April 20, 1999, at the Argonne National Laboratory—East, reflected laser light burned a ceiling tile in the laser laboratory while a researcher welded two 24-inch-long aluminum plates with a 6-kW CO_2 laser. The researcher operated the laser at a power level of 4 kW for approximately 5 sec but did not follow procedures to prevent reflected light. He then shut off the laser beam and took the aluminum plates to another room for examination. A few minutes later a smoke detector in the laser room alarmed. The researcher noticed smoke coming from one of the ceiling tiles above the laser and he shut off the high voltage power to the laser. Firefighters arrived and determined that there was no fire. They removed the charred ceiling tile. The laser safety officer directed that the laser not be operated until appropriate safety measures can be defined, approved, and implemented. (ORPS Report CH-AA-ANLE-ANLEER-1999-0005)

In the past, researchers performed laser welding of aluminum plates at the facility without incident. However, the plates were shorter then, and the weld times were approximately 2 sec. Investigators believe that the ceiling tile was charred by laser light that reflected off the weld surface. The laser has two operating positions, vertical and 10 degrees off vertical. When the laser is operated off vertical, safe operating procedures require that a beam stop (or shield) be used to protect against reflected light. Investigators determined that the researcher operated the laser 10 degrees off vertical and without the beam stop.

The CO_2 laser is a widely used laser in which the primary lasing medium is CO_2 gas with a wavelength of 10.6 µm (10,600 nm) and which can be operated in either of two modes: continuous wave or pulsed. It is classified as a Class IV laser, which is a high-power laser hazardous to the eyes under any condition (directly or diffusely scattered). Because Class IV lasers can also start fires and are a potential skin hazard, significant controls are required for Class IV laser facilities. Laser hazard classes signify the level of hazard inherent in a laser system and the extent of safety controls required. Class I is the least hazardous and Class IV is the most hazardous. Complete definitions for each class are contained in ANSI Z136.1-1993, *American National Standard for the Safe Use of Lasers*. The American Welding Society, Inc., publication *Safe Practices* provides guidance on general welding safety and on laser beam welding and cutting. It states that if a plasma is generated at high power during the operation of a CO_2 laser, extreme brilliance can result.

NFS has reported other events involving lasers in the Weekly Summary. These events included violating safety interlocks, operating lasers unattended, and failing to wear appropriate eye protection. It is important to understand that because the reflected beam intensity of a laser may approach its direct beam intensity, care must be exercised to prevent or minimize reflections from objects or surfaces in the area of the laser. Laser operators need to be concerned not only with personnel safety (skin burns and eye damage) but also with the effect direct and reflected laser light can have on combustible materials in the vicinity of the laser.

Managers of facilities using lasers should ensure that laser operators understand hazard controls unique to laser operations and must enforce adherence to safe operating procedures. Training should include information from ANSI Z136.1-1993.

This standard provides guidance for the safe use of lasers and laser systems by defining hazard control measures for each of the four laser classes. Control measures include (1) engineering controls, such as beam housings, beam shutters, and attenuators; (2) administrative controls, such as procedures, warning signs, labels, and training; and (3) personal protective equipment, such as eyewear, gloves, and special clothing. This standard is endorsed in part by DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, paragraph 12, “Contractor Requirements Document.”

KEYWORDS: fire, industrial safety, laser, procedure, welding

FUNCTIONAL AREAS: Industrial Safety, Procedures

4. WORKER BURNED DURING WELDING OPERATION

On April 29, 1999, at the Los Alamos National Laboratory, a mechanical technician sustained second-degree burns to his left forearm and hand while welding a container in a welding shop. The technician’s welder ignited vapors from the ethanol that was used to clean the inside of the container. The ignited vapors flashed, contacting his forearm and charring and burning holes in a cotton glove that he was wearing. A coworker immediately transported him to the Los Alamos Medical Center emergency room, where he was treated and referred to a burn and trauma center in Albuquerque for evaluation and treatment of the injury. Medical personnel at the burn center evaluated the burns as second degree and released the technician the same evening. This event is significant because flammable vapors came in contact with an ignition source and resulted in an injury. (ORPS Report ALO-LA-LANL-TSF-1999-0001)

The mechanical technician was re-welding joints in a 15-gal stainless steel drum that had been modified to serve as a container for molecular sieve material. The joints had failed an earlier helium leak detection test. The technician was experienced in the operations associated with modifying drums of this type. At the time of the accident, he was working in the welding shop and he wore an approved welder's hood and smock, as well as cotton gloves to give the dexterity and grip necessary for fine welding.

Investigators determined that in preparation for the re-weld, a coworker had cleaned the interior of the drum with approximately a half cup of ethanol to remove suspected residual oil from earlier cutting and drilling. After cleaning the drum, he set it upside down to drain into a waste container used for ethanol waste and to evaporate. Approximately an hour later, he set the drum upright on a work cart to be welded. The mechanical technician knew the drum had been cleaned out with ethanol, but he believed the ethanol had been purged from it. He proceeded to re-weld the joints and held his tungsten inert gas (TIG) arc welder in his left hand over an opening in the container. The TIG welder ignited the ethanol vapor, causing a flash that contacted his left forearm.

A Laboratory investigative team was formed to review this event. The Tritium Science Engineering managers called a stand-down of shop operations to review procedures and housekeeping. Facility personnel are reviewing the following precautions for possible inclusion in facility safety practices.

- Development of procedures and requirements for designated welding areas. These would stress proper personal protective equipment and the need to always purge vessels before welding.

- Require a work instruction/checklist for cleaning and welding barrels so welders would know what has been done to the barrel before welding.

- Require workers to check with supervisors when they find abnormal conditions (e.g., cutting oil in the bottom of a barrel).

ANSI/ASC Z49.1-94, *American National Standard for Safety in Welding, Cutting, and Allied Processes*, provides guidance for performing welding and cutting operations safely. It states that when containers (drums and tanks) that have held flammable or hazardous substances are being welded or cut, there is the possibility of explosion, fire, or release of toxic vapors or fumes. Workers should also review ANSI/AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping.* Additional standards for welder qualifications and inspections, as well as information on a wide variety of welding topics, are available from the American Welding Society (AWS). AWS standards have been adopted by ANSI. The Society's URL is http://www.amweld.org/.

NFS has reported other events in the Weekly Summary where flammable materials came in contact with ignition sources. Some examples follow.

- Weekly Summary 98-39 reported that a lubricant ignited when a mechanic at the Hanford Site sprayed it on a truck-mounted drill-head assembly he was repairing. The fire lasted less than 30 seconds and there were no injuries. Investigators believe that a static electric charge ignited the spray lubricant. The lubricant was an aluminum-complex-based grease that used butane, isobutane, propane, and hexane as propellants. (ORPS Report RL--PHMC-TANKFARM-1998-0117)

- Weekly Summary 98-13 reported that two electricians at the Los Alamos National Laboratory Accelerator Complex received burns to their hands and faces when vapors from an aerosol electrical contact cleaner contacted an electrical space heater, ignited, and formed a fireball. They were using the cleaner while performing maintenance on electrical transformers. Investigators determined that use of the space heater was not specified in the work package, and they believe that no one had performed a chemical hazard analysis before the electricians began work. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1998-0005)

OEAF engineers also reviewed a final report this week that involved the ignition of flammable vapors. On December 29, 1998, at the Pantex Plant, a fire occurred when isopropyl alcohol vapors ignited while a production technician was using the alcohol to remove sealant material from a weapon component. The production technician quickly extinguished the fire with a fire extinguisher. Investigators believe the ignition source was either an electrostatic discharge or a frictional spark. They determined the root cause of the event to be a lack of controls that would have eliminated or reduced the potential for flammable alcohol vapor concentrations or possible ignition sources. The lack of controls included inadequate dissemination of information on isopropyl alcohol flammability. The Material Safety Data Sheet for isopropyl alcohol clearly calls attention to its flammability. Also, lessons learned from a similar flash fire involving isopropyl alcohol were not incorporated into the cleaning process. (ORPS Report ALO-AO-MHSM-PANTEX-1998-0094)

These events underscore the importance of ensuring that flammable materials and ignition sources are controlled and kept separate to prevent explosion or fire. In the case of welding, where the work involves the use of an ignition source, flammable materials should be kept away from the area. The safeguards should include purging containers of residual vapors and fumes that may be present following preparation work. When solvents, aerosols, and other flammable cleaners are being used, it is important to guard against the presence of an ignition source, such as an open flame, spark, friction, and electrostatic discharge. It is also important that workers are trained in the safe use of flammable materials. Facility managers should review their use of flammable cleaners and aerosol products and ensure that hazards associated with their use are evaluated and mitigated.

- DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, states that the contractor must identify workplace hazards and evaluate the risk of associated worker injury or illness.

- DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The order requires using control procedures to help personnel understand the requirements for working safely.

KEYWORDS: burn, combustible materials, drum, ethanol, flammable, injury, welding

FUNCTIONAL AREAS: Hazards Analysis, Industrial Safety

5. PROCEDURE VIOLATED DURING TANK TRANSFER

On April 20, 1999, at the Savannah River H-Canyon Facility, while operators were attempting to decant one tank to another, a shift operating manager entered the control room and questioned why an agitator in the sending tank was operating during a decant. The normal method of transferring tank contents consists of running an agitator only in the receiving tank. The agitator in the sending tank is not run during the decant to prevent remixing of the contents. At approximately the same time, the control room operator discovered that the agitator in the receiving tank was out of service. The shift operating manager immediately directed operators to turn off the agitator in the sending tank and terminate the transfer. Inadvertent or improper transfers of solutions can result in the mixing of incompatible chemicals or solutions, tank overflows, contamination of clean systems, and criticality safety implications. (ORPS Report SR--WSRC-HCAN-1999-0025)

Investigators for this occurrence determined the following.

- The facility is in the process of restarting the process after a prolonged shutdown.

- The control room operator was qualified but had never actually performed the decanting operation.

- The control room operator was being assisted by a newly assigned auxiliary operator, and the two were communicating by telephone during the transfer.

- Because the agitator in the tank that would normally receive the decanted liquid was inoperative, facility engineers had written an immediate procedure change (IPC) that called for transferring the decanted liquid temporarily to a third tank with an operable agitator.

- IPCs are not retained as active documents. They are developed by facility personnel for one-time-only use, after which they are archived.

- The control room operator was not aware of the IPC. It had not been discussed in shift turnovers or shift briefings and had not been included with the procedure it was intended to modify. A qualified operator who was aware of the IPC was absent during the transfer. Consequently, the control room operator carried out the transfer procedure without the IPC.

- The shift operating manager and other operators had focused their attention on a complex evolution about to start at the same time as the tank transfer operation. Believing the transfer to be rather straightforward, neither the shift operating manager nor the control room supervisor conducted a pre-job briefing or directly oversaw the transfer operation.

- The control room operator instructed the auxiliary operator to start the tank agitator. She does not recall her exact words or whether she identified the component by its tag number. In any case, the auxiliary operator started the wrong agitator and the condition went unnoticed until the shift operating manager reentered the control room.

NFS has reported inadvertent solution transfers in numerous Weekly Summaries. The following are among them.

- Weekly Summary 98-34 reported that operators at the Hanford Site Liquid Waste Processing Facility inadvertently sent 5,500 gal of process condensate from an evaporator to a storage tank in the 200 East Area Tank Farm. Oncoming shift personnel noticed that a two-way diverter valve was in the divert position. Because they knew the valve should be in the divert position only in response to a signal from the leak detection system, they investigated and determined that the inadvertent transfer had occurred during the previous shift. Investigators determined that a leak detection alarm had shut down a transfer pump and repositioned the diverter valve. An operator reset the alarm and restarted the transfer pump because he believed the alarm was spurious. He did not refer to procedures for recovering from the alarm, which require repositioning of the diverter valve before resuming a transfer. The transfer continued for approximately 3 hr with the diverter valve in the improper position. (ORPS Report RL--PHMC-200LWP-1998-0009)

- Weekly Summary 97-23 reported that operators at the Savannah River FB-Line Facility inadvertently transferred solution from the wrong cation concentrate batch tank to a precipitator feed tank. While an operator was performing a valve lineup, he accidentally read steps from the wrong page of a procedure—steps that pertained to a sister tank. The error caused the transfer of some solution from the correct tank and some from an incorrect tank. The operators realigned the valves when they realized their mistake. They stopped the transfer but did not inform the shift operating manager or supervisor of the error. An engineer discovered the depletion of solution from the wrong batch tank during a review of the facility material control and accountability procedures. Investigators determined that the operators did not report the valve misalignment because they did not consider it to be a problem and that they did not monitor tank level changes on strip chart recorders during the transfer. Investigators also determined that not all operators involved in the transfer had a copy of the procedure and that some had not attended the pre-job briefing. (ORPS Report SR--WSRC-FBLINE-1997-0019)

NFS engineers searched the entire ORPS database for occurrence descriptions containing (inadvertent OR accident*) AND transfer AND (liquid OR fluid OR solution) and located 257 occurrences. Facility managers cited personnel error as the direct cause of 114, or nearly half, of these occurrences. Other direct causes include management problems (75), equipment or material problems (33), and procedure problems (16). Of the 75 management problems, 58 were classified as inadequate administrative control or supervision. The data indicate that the majority of inadvertent transfer occurrences are directly caused by conduct of operations issues.

Inadvertent transfers can cause problems. Solutions containing fissile materials may be subject to inadvertent criticality. For many solutions, reactions between incompatible chemicals can produce explosive, corrosive, or gas-generating mixtures. Another area of concern is the potential for the off-site release of radiation or hazardous chemicals. DOE Defense Programs Safety Information Letter SIL 95-05, *Inadvertent Transfer of Liquid Solutions,* June 1995, addresses the safety problems raised by inadvertent transfers of solutions and includes recommendations for preventing or mitigating inadvertent liquid transfers.

Use Procedures — The proper use of procedures reduces the chance of unexpected results. Proper communication plays an important role in directing an evolution from a remote location. It involves a "reader-worker" approach, where the controlling operator reads the procedure and a worker carries out the steps locally. Proper execution requires that the reader read a step verbatim, that the worker repeat the step verbatim, that the worker carry out the step and report that it has been carried out, and that the reader acknowledge that the step has been carried out.

Verify Lineups — Checking system alignment should guarantee the solution goes to the expected location. All lineups should be physically walked down and checked against facility documentation to identify any discrepancies. Valve and switch lineups should be independently verified when the consequences of error are unacceptable. Independent verifiers should be trained to expect errors.

Hold Detailed Briefings — Conduct a detailed briefing with all parties involved in a test activity or an unusual or infrequent operation before it takes place. Ensure that each person understands what is expected and what actions are to be taken if something unexpected happens. The briefings should identify important parameters and instrumentation to be monitored.

One Task at a Time — Ensure that each evolution is complete and the parameters stabilized before beginning another task, if the situation allows. Where multiple evolutions must be performed, ensure adequate supervision of each.

Prepare Contingency Plans — When preparing for any evolution, think about what may go wrong and for each possible event ensure that guidance is provided to mitigate it. Include identification of parameters and instrumentation that would indicate an unusual event is occurring.

Practice Self-Checking — Use the STAR principle: Stop, Think, Act, Review. Pause before acting. Think about what you are about to do. What responses do you expect? Have you selected the proper component? Carry out the action. Review the result of the action. Is the result what you expected? In the case of fluid transfers, is the intended source decreasing and is the intended receiver increasing?

Exercise Stop-Work Authority — Stop work immediately, restore safe conditions, and report any condition that is abnormal or was not expected.

These principles should be incorporated into initial and periodic conduct-of-operations training programs. They should be re-emphasized at shift briefings, pre-job briefings, and safety meetings.

KEYWORDS: conduct of operations, procedures, tank, transfer

FUNCTIONAL AREAS: Conduct of Operations, Operations, Procedures

FINAL REPORT

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. CHEMIST RECEIVES CHEMICAL BURNS WHEN CONTAINER OVERPRESSURIZES AND RUPTURES

On April 1, 1998, at the Lawrence Livermore National Laboratory, a chemist received chemical burns to his head when a plastic bottle ruptured and sprayed its contents on him and throughout the hazardous waste radiological laboratory he was working in. The injured chemist was one of two chemists assigned to work on the samples. The previous day, they began mineral acid digestion of six oil samples. While these samples were in the initial stages of digestion, the chemists realized that they had already been analyzed. One of the chemists added the samples to a transient waste collection bottle for disposal. This bottle was an empty hydrogen peroxide bottle that was being used to collect spent acids at the workstation. It was equipped with a vented cap. The bottle was left overnight on the laboratory bench top. The next morning, one of the chemists entered the laboratory, noticed that the bottle was bulging, and heard it hissing. Before he could react, the bottle ruptured. Some of the contents of the bottle splashed on the chemist. Most of the acid mixture was kept off the chemist's skin by his lab coat, safety glasses, and shirt. A small amount did strike him in the face and head, resulting in chemical burns to his skin. The chemist washed the acid mixture off his face in the men's restroom. He did not use the safety shower in the room he was working in because the room was filled with acid vapors, nor did he use the safety shower in any of the adjacent laboratories. The chemist transported himself to an on-site health services facility. Medical personnel noted that some acid mixture was still in his hair, so they shampooed and showered him, treated the chemical burns, and released him. Occurrence investigators believe that the delay resulting from not using a shower in the laboratory building resulted in chemical burns and 12 restricted work days. (ORPS Report OAK--LLNL-LLNL-1998-0025 and Weekly Summary 98-18)

Occurrence investigators determined that the direct cause of this accident was the inappropriate storage of the acid mixture. Gas generation caused the container to pressurize and rupture. Investigators identified the following contributing causes.

> **Error in Equipment or Material Selection** — Use of the empty hydrogen peroxide bottle as a transient waste container was inappropriate. While this bottle is vented for the evolution of gas from the degradation of hydrogen peroxide, it is not designed for the highly acidic vapors and the volume of gas generation resulting from the sample digestion process.
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> **Inattention to Detail** — Both chemists failed to recognize the hazard involved in aborting a digestion without considering the ongoing reactivity of the resulting

mixture or consulting others as to the appropriateness of their actions and the type of waste container selected.

Policy Not Adequately Defined/Disseminated/Enforced — The laboratory failed to fully execute its written quality assurance plans for training personnel in the chemical procedures governing its operations. The laboratory supervisor had not completed the performance-based demonstration of proficiency required for the State of California Environmental Laboratory Accreditation Program Certification.

Investigators concluded that the root cause was that the procedure for waste disposal was not used correctly. Lawrence Livermore National Laboratory written requirements for the safe handling and storage of waste clearly discuss appropriate waste containers, proper labeling, and the dangers of storing incompatible materials together. Both chemists were trained on this procedure and both were current in this training.

Investigators also discovered that laboratory employees are reluctant to use safety showers. Employees attributed their reluctance to the following factors: (1) a fear of creating an environmental accident or overloading the building retention system by using the shower, (2) the desire not to flood nearby operations, either on the same floor or on lower floors, (3) the fear that management and peers would react negatively to a flood resulting from safety shower use, and (4) embarrassment related to disrobing in a public area. These findings indicate that management needs to better communicate the precedence of personnel safety over programmatic and facility operations, as well as to reassert that spills to the environment or the facility retention system are preferable to employee injury.

Some of the corrective actions identified by facility management follow.

- Review practices related to chemical handling and ensure the appropriate selection and use of waste containers.
- Issue a mandate that digestions are not to be interrupted but should be carried through to a normal, safe termination.
- Assess the location, accessibility, and administrative expectations of use for safety showers.

This incident demonstrated the necessity to evaluate hazards resulting from abnormal termination of a process as well as hazards encountered in the process. The reactive mixture created as part of the chemical digestion operation was managed safely during the digestion, but when that operation was abnormally terminated before completion, the hazard of storage and disposal of that mixture needed to be considered. This incident also demonstrated that prompt use of safety showers probably would have reduced the severity of the chemical burns.

KEYWORDS: chemical reaction, pressurized, injury, acid

FUNCTIONAL AREAS: Materials Handling/Storage, Procedures

OEAF FOLLOW-UP ACTIVITY

1. CORRECTION TO WEEKLY SUMMARY 99-16, ARTICLE 4

The article incorrectly stated that the Advanced Nuclear Technology group at the Pajarito Laboratory at Los Alamos conducted a deliberate operation of a burst-type reactor in order to determine the external exposures of security force personnel. In fact, the purpose of the operation was to test criticality alarm systems and not to specifically record personnel external exposures. Facility personnel had previously reviewed and evaluated issues of external dose at this facility with personnel from Operations, Facility, Environment Safety and Health, Security (including Protection Technology Los Alamos), and the DOE/Los Alamos Area Office. They had performed dose measurements at various site locations where security police officers would be stationed in order to establish baseline dose levels during facility operations as part of a formal ALARA review. These measurements were conducted without personnel, using only dosimetry phantoms and thermoluminescent dosimeters (TLDs). The only reason the radiological work permit required that security officers use an additional temporary TLD (as stated in the article) was to collect ALARA data and provide timely information that would reassure the officers of their actual dose levels.

KEYWORDS: dosimeter, external exposure, radiation protection, radiological work permit, respirator, security, thermoluminescent dosimeter

FUNCTIONAL AREAS: Radiation Protection